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GB 0674876 A US 5064570 A US 4857110 A
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(54) Coating composition

(57) A process for preparing a coating composition for use in preparing a coated cellulosic sheet member, comprises the step of combining, in an aqueous medium, a paper coating pigment, a dispersing agent for the pigment, an adhesive and an emulsified long chain fatty acid or alcohol. The coated sheet may be subsequently printed by a gravure process.

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A COATING COMPOSITION

This invention concerns an improved coating composition for use in preparing a coated cellulosic sheet material, for example paper or cardboard, which has special advantages when the coated sheet material is printed by the rotogravure process.

Coating compositions for cellulosic sheet materials generally comprise an aqueous suspension of one or more pigments and one or more adhesive materials, together with small amounts of other additives such as rheology modifiers, lubricants etc. The most commonly used pigments are generally natural or synthetic inorganic materials of white colour and of relatively fine particle size distribution such that at least 45% by weight of the particles have an equivalent spherical diameter (esd) smaller than 2μm, when measured by a sedimentation method. Examples of pigments which are commonly used in coating compositions for cellulosic sheet materials are kaolin clay, calcined kaolin clay, natural or precipitated calcium carbonate, satin white, calcium sulphate and talc.

The rotogravure printing process is generally most suited to those applications in which a very large number of copies is required to be printed, because the process by which a rotogravure printing cylinder is prepared is expensive relative to the cost of preparing printing plates for use in other methods of printing. A rotogravure printing cylinder has on its surface a matrix of cells or depressions which vary in depth according to the amount of ink which is required to be transferred to the paper from each individual cell. The surface of the cylinder is initially smooth and highly polished, and the matrix of cells on the surface is prepared by an expensive photographic etching process. Because of the large number of copies to be

printed, it is generally desirable to run the printing press at high speed, and this necessitates the use of a printing ink which dries quickly on the paper to avoid "offset", or the transfer of undried printing ink from one sheet of paper to the next. It is therefore desirable to use a printing ink which has a solvent which is more volatile than water. In addition a solvent-based ink generally gives better print quality than a water-based ink. Such volatile solvents are almost always organic and oleophilic.

It has been discovered in the paper coating industry that, when large reels of paper are wound or unwound at high speed, frequent breakages can occur in the web of coated paper. One cause of this is believed to be the relatively high coefficient of friction of the coated surface of certain types of coated paper, which limits the freedom of movement of one turn of a reel of coated paper relative to an adjacent turn.

In order to reduce or eliminate this problem, some operators include in the coating composition from 10% to 45% by weight of talc in the total dry weight of the pigment in the composition. This reduces the coefficient of friction of the surface of the coated paper prepared using the composition and gives it a "slippery" feel. Talc of the required quality is, however, expensive, and in some cases, the slippery surface of the coated paper can cause problems in printing processes in which the paper is used.

It is also known (see for example TAPPI Monograph Series No. 25 "Paper Coating Additives", Chapter 2, "Lubricants" by R.B.Porter, Technical Association of the Pulp and Paper Industry, New York, 1963) to include in a paper coating composition as a lubricant or "levelling agent" a small quantity of a water-soluble soap, such as sodium or ammonium stearate, or of a soap which is insoluble, but dispersible, in water such as

calcium or aluminium stearate.

EP-A-0565691 discloses a method whereby a calcium carbonate pigment is treated with a saturated or unsaturated fatty acid prior to the preparation of the paper coating pigment.

According to a first aspect of the present invention, there is provided a coating composition for preparing a coated cellulosic sheet material which comprises an aqueous suspension of an adhesive, a particulate paper coating pigment, a dispersing agent for the pigment and an emulsified long chain fatty acid or alcohol.

The coating composition is preferably a paper coating composition. A web of paper coated with a composition in accordance with the invention may be reeled and unreeled at high speed with diminished risk of breakage, as compared with webs which have been coated with conventional compositions. Also, it is found that, surprisingly, a web of paper which has been coated with a composition in accordance with the invention gives superior print quality on printing by a rotogravure process, as compared with a web of paper which has been coated with a conventional composition comprising an aqueous suspension of an adhesive, a particulate inorganic pigment and a dispersing agent.

The particulate paper coating pigment may be, for example, an inorganic pigment such as kaolin or china clay, a calcined kaolin, natural or precipitated calcium carbonate, satin white, talc, calcium sulphate or a blend of any two or more of these. The pigment will normally be present in the coating composition in an amount of at least about 45% by weight, based on the total weight of the composition (including water in the composition), and will normally be present in an amount no greater than about 70% by weight.

The amount of adhesive solids present in the

composition will vary according to the type of adhesive used and the type of process by which the coated paper is to be printed, but will generally be in the range of 3% to 20% by weight, based on the dry weight of the pigment. Preferably, the adhesive is a latex in which case it is preferred that the quantity of the latex used is such that the amount of latex solids is in the range from 3% to 6% by weight, based on the weight of dry pigment. The latex may be, for example, a styrene-butadiene latex or an acrylic latex, which may or may not be of the alkali-swelling type. The latex to be employed will normally be one which is in the form of an aqueous emulsion containing about 40% to 60% by weight of latex solids, preferably about 50% by weight of latex solids. Starch is another possible adhesive which may be used in the coating composition of the invention.

The dispersing agent may be of the type conventionally used in coating compositions for cellulosic sheet material, for example, inorganic dispersing agents such as the water soluble salts of polyphosphoric acid or of polysilicic acid, or polycarboxylate dispersing agents such as the water soluble salts of poly(acrylic acid) or of poly(methacrylic acid). Mixtures of different dispersing agents are also operable. Typically, the amount of the dispersing agent used will be at least 0.05% by weight, based on the weight of dry pigment, and will preferably be no greater than 0.5% by weight, based on the weight of dry pigment, preferably from 0.1% to 0.4% by weight.

The hydrocarbon chain of the fatty acid or alcohol should preferably have a length of from 8 to 22 carbon atoms, more preferably from 12 to 22 carbon atoms. Preferably, the hydrocarbon chain is linear and saturated. The carboxylic acid is preferably a

monocarboxylic acid and the alcohol is preferably a monoalcohol. A presently preferred long chain alcohol is cetyl (C_{16}) alcohol and a presently preferred long chain fatty acid is stearic acid. The emulsified long chain fatty acid or alcohol is normally formed as an emulsion in water of the fatty acid or alcohol with the aid of an emulsifying agent. Thus, for example, the emulsion may be formed by preparing an aqueous mixture of the fatty acid or fatty alcohol and the emulsifying agent, and vigorously agitating the mixture, preferably at an elevated temperature, until a stable emulsion is formed. The emulsion preferably has a mean particle size not greater than 1μm and a zeta potential in the range of from -30 to -70mV. An example of a suitable emulsifying agent is a sodium sulphosuccinate dioctyl ester, although other emulsifying agents which are compatible with the fatty acid or alcohol, such as sulphonated alcohol ethoxylates will also be suitable. The amount of emulsifying agent used is typically at least 0.5% by weight, based on the weight of the fatty acid or fatty alcohol, and preferably no greater than 5.0% by weight.

The amount of the emulsified long chain fatty acid or alcohol in the coating composition of the invention is preferably at least 0.5% by weight, based on the weight of dry pigment, and preferably no greater than 5.0% by weight. More preferably, the emulsified long chain fatty acid or alcohol in the coating composition of the invention is present in an amount in the range of from 1.5% to 3.0% by weight, based on the weight of dry pigment.

According to a second aspect of the present invention, there is provided a process for preparing a coating composition for use in preparing a coated cellulosic sheet member, which comprises the step of combining, in an aqueous medium, a paper coating

pigment, a dispersing agent for the pigment, an adhesive and an emulsified long chain fatty acid or alcohol. Normally, the ingredients will be mixed together under agitating conditions to ensure that a homogenous mixture is obtained. The emulsified long chain fatty acid or alcohol may be prepared as an emulsion as described above.

According to a third aspect of the present invention, there is provided a coated cellulosic sheet member prepared by applying a coating composition in accordance with the first aspect of this invention to a surface of a base cellulosic sheet member and permitting said coating to dry.

More details of the manner in which coated sheet members may be prepared can be found in Chapter 1 ("Mineral Pigmented Coatings") of the book "Coating Equipment and processes" by George L. Booth, Lockwood Publishing Co. Inc., New York, 1970.

Typically, the coated sheet member of the invention has a coat weight in the range of from 4 to $12 m^2 g^{-1}$. The coated sheet member of this aspect of the invention will normally possess a coefficient of friction less than 0.3, although this figure can vary somewhat with base paper type, coat weight and other factors.

According to a fourth aspect of the present invention, there is provided a gravure printing process in which an image is printed onto the surface of a coated sheet member in accordance with the third aspect of the present invention. The gravure printing process is described in general terms at pages 42-52 of the book "The Printing Ink Manual", 5th Ed., edited by R.H. Leach and R.J. Pierce, Chapman and Hall, London, 1993.

The invention will now be illustrated by reference to the following examples.

EXAMPLE 1

Five paper coating compositions (A and B being comparative; C, D and E being in accordance with the invention) were prepared according to the recipes given in Table 1 below:

Table 1

	A	B	C	D	E
Clay 1	100	70	100	100	100
Talc 1	0	30	0	0	0
Styrene-butadiene latex adhesive	5.0	5.0	5.0	5.0	5.0
Cetyl alcohol	0	0	1.0	2.0	4.0
Sodium hydroxide	to give pH 8.5				
Water	to 57.0% by weight dry solids				

The amount of each pigment is given in parts by weight of the total pigment. The amount of the latex adhesive is given as the percentage by weight of latex solids, based on the weight of the dry pigment. The amount of cetyl alcohol is the percentage by weight, based on the weight of the dry pigment.

In the above compositions:

Clay 1 was a kaolin clay having a platey particle shape (an aspect ratio of about 50) and a particle size distribution such that 65% by weight consisted of particles having an equivalent spherical diameter smaller than 2μm and 40% by weight consisted of particles having an equivalent spherical diameter smaller than 1μm.

Talc 1 was a paper coating grade talc having a particle size distribution such that 45% by weight consisted of particles having an equivalent spherical diameter smaller than 2μm and 25% by weight consisted of particles having an equivalent spherical diameter smaller than 1μm.

The cetyl (C_{16}) alcohol was added as an emulsion

which was prepared by heating 800g of water to 80°C and adding to this 10g of a sodium sulphosuccinate dioctyl ester emulsifying agent, which is marketed under the trade name "AEROSOL OT". To this mixture was added 200g of cetyl alcohol. The mixture was vigorously stirred during the addition of the cetyl alcohol, and for a further 10 minutes thereafter, while the temperature fell to 4°C. The emulsion so formed was then allowed to stand until it had cooled to room temperature. Analysis using a Malvern Zetasizer showed that the emulsion had a mean particle size of 0.35μm and a zeta potential of -70mV.

The compositions were applied to a rotogravure base paper of weight 39g.m^{-2}, using a laboratory coating machine of the type described in British Patent Specification No. 1032536 at a paper speed of 400m.min^{-1} and a blade holder angle of 45°. Coatings were applied to sheets of the base paper at different weights per unit are in the range from about 5 to 10g.m^{-2} by adjusting the loading on the blade. Each sheet of coated paper was conditioned for 24 hours at 23°C and 50% relative humidity, and were then calendered by 10 passes through a Perkins laboratory supercalender at a temperature of 65°C, a pressure of 69 bar and a speed of 36m.min^{-1}. The sheets of calendered coated paper were tested for gloss, coefficient of friction, gravure print quality (% missing dots) and print density, the results for gloss, gravure print quality and print density being plotted graphically against coat weight, and the result corresponding to a coat weight of 7g.m^{-2} being found by interpolation. In the case of the coefficient of friction, measurements were made at a coat weight which was as near as possible to 7g.m^{-2}. The results obtained are set forth in Table 2 below:

Table 2

Composition	Gloss	Coefficient of Friction	% Missing Dots	Print Density
A	57	0.274	1.4	2.01
B	58	0.223	1.1	1.97
C	59	0.256	1.1	2.01
D	59	0.235	0.9	1.98
E	59	0.241	0.4	1.92

EXAMPLE 2

Three further paper coating compositions (F and G being comparative and H being in accordance with the invention) were prepared according to the recipes given in Table 3 below:

Table 3

	F	G	H
Clay 1	0	0	100
Clay 2	100	80	0
Talc 1	0	20	0
Cetyl alcohol	0	0	2.0
Styrene-acrylic (alkali-swellable) latex adhesive	5.0	5.0	5.0
Sodium hydroxide	to give pH 8.5		
Water	to give 53.0% by weight dry solids		

Clay 2 was a kaolin clay having a platey particle shape (an aspect ratio of about 50) and a particle size distribution such that 68% by weight consisted of particles having an equivalent spherical diameter smaller than 2μm and 45% by weight consisted of particles having an equivalent spherical diameter smaller than 1μm.

The cetyl alcohol was added in the form of an aqueous emulsion which was prepared as described in

Example 1 above.

These compositions were coated on to a rotogravure base paper of weight 39g.m^{-2}, and the coated sheets conditioned, calendered and tested as described in Example 1 above.

The results of the tests which corresponded to a coat weight of 7g.m^{-2} were found by interpolation, except for the coefficient of friction results which were each found by measurements at a coat weight which was as near as possible to 8g.m^{-2}. The results obtained are set forth in Table 4 below:

Table 4

Composition	Gloss	Coefficient of Friction	% Missing Dots	Print Density
F	49	0.263	2.6	1.95
G	51	0.243	2.3	1.94
H	54	0.235	1.5	1.92

EXAMPLE 3

Three further paper coating compositions (I and K comparative and J being in accordance with the invention) were prepared according to the recipes given in Table 5 below:

Table 5

	I	J	K
Clay 1	100	100	100
Styrene-butadiene latex adhesive	5.0	5.0	5.0
Stearic acid	0	3.8	0
Calcium stearate	0	0	2.0
Sodium hydroxide	to give pH 8.5	0	to give pH 8.5
Water	to 57.0% by weight dry solids		

In the case of composition J, the stearic acid was added in the form of an aqueous emulsion which was

prepared by following exactly the same procedure as was described in Example 1 in connection with cetyl alcohol. The pH was not adjusted from its natural value of approximately 6.5.

These compositions were coated on to a rotogravure base paper of weight 39g.m^{-2}, and the coated sheets conditioned, calendered and tested as described in Example 1 above.

The results of the tests which corresponded to a coat weight of 7g.m^{-2} were found by interpolation, except for the coefficient of friction results which were each found by measurements at a coat weight which was as near as possible to 7g.m^{-2}. The results obtained are set forth in Table 6 below:

Table 6

Composition	Gloss	Coefficient of Friction	% Missing Dots	Print Density
I	48	0.27	3.6	1.95
J	53	0.20	1.5	1.83
K	50	0.22	3.4	1.93

These results clearly show the superior rotogravure print performance of the composition containing the stearic acid emulsion compared with the composition containing calcium stearate.

CLAIMS:

1. A coating composition for preparing a coated cellulosic sheet material which comprises an aqueous suspension of an adhesive, a particulate paper coating pigment, a dispersing agent for the pigment and an emulsified long chain fatty acid or alcohol.

2. A coating composition according to claim 1, wherein the particulate paper coating pigment is an inorganic pigment selected from a kaolinitic clay, a calcined kaolinitic clay, natural or precipitated calcium carbonate, satin white, talc, calcium sulphate or a blend of any two or more of these.

3. A coating composition according to claim 1 or 2, wherein the pigment is present in the coating composition in an amount of from 45% to 70% by weight, based on the total weight of the composition.

4. A coating composition according to claim 1, 2 or 3, wherein the quantity of adhesive present in the composition is such that the amount of adhesive solids is from 3% to 20% by weight, based on the dry weight of the pigment.

5. A coating composition according to any preceding claim, wherein the adhesive is a latex.

6. A coating composition according to claim 5, wherein the quantity of the latex used is such that the amount of latex solids is in the range from 3% to 6% by weight, based on the weight of dry pigment.

7. A coating composition according to any preceding claim, wherein the dispersing agent is an inorganic dispersing agent or a polycarboxylate dispersing agent.

8. A coating composition according to claim 7, wherein the amount of the dispersing agent is in the range of from 0.05% to 0.5% by weight, based on the weight of dry pigment.

9. A coating composition according to any

preceding claim, wherein the hydrocarbon chain of the fatty acid or alcohol has a length of from 8 to 22 carbon atoms.

10. A coating composition according to claim 9, wherein the hydrocarbon chain of the fatty acid or alcohol has a length of from 12 to 22 carbon atoms.

11. A coating composition according to any preceding claim, wherein the emulsified long chain fatty acid or alcohol is formed as an emulsion in water of the fatty acid or alcohol with the aid of an emulsifying agent.

12. A coating composition according to claim 11, wherein the emulsion has a mean particle size not greater than 1μm.

13. A coating composition according to claim 11 or 12, wherein the emulsion has a zeta potential in the range of from -30 to -70mV.

14. A coating composition according to any preceding claim, wherein the amount of the emulsified long chain fatty acid or alcohol in the coating composition is in the range of from 0.5% to 5.0% by weight, based on the weight of dry pigment.

15. A process for preparing a coating composition for use in preparing a coated cellulosic sheet member, which comprises the step of combining, in an aqueous medium, a paper coating pigment, a dispersing agent for the pigment, an adhesive and an emulsified long chain fatty acid or alcohol.

16. A coated cellulosic sheet member prepared by applying a coating composition as claimed in any one or more of the preceding claims to a surface of a base cellulosic sheet member and permitting said coating to dry.

17. A gravure printing process in which an image is printed onto the surface of a coated sheet member as claimed in claim 16.

18. A coating composition as claimed in claim 1, substantially as hereinbefore described, with reference to the accompanying examples.

19. A process for preparing a coating composition as claimed in claim 15, substantially as hereinbefore described, with reference to the accompanying examples.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9520978.9
Relevant Technical Fields (i) UK Cl (Ed.O) C3V (VABP, VABR, VABS, VABT, VABX) (ii) Int Cl (Ed.6) D21H	Search Examiner K MACDONALD Date of completion of Search 24 JANUARY 1996
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI	Documents considered relevant following a search in respect of Claims :- 1-19

Categories of documents

X:	Document indicating lack of novelty or of inventive step.	P:	Document published on or after the declared priority date but before the filing date of the present application.
Y:	Document indicating lack of inventive step if combined with one or more other documents of the same category.	E:	Patent document published on or after, but with priority date earlier than, the filing date of the present application.
A:	Document indicating technological background and/or state of the art.	&:	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 674876	(MONSANTO CHEMICAL) Claim 1, page 2, lines 35-43, page 3, lines 84-87	at least Claims 1, 15
X	US 5064570	(CIBA-GEIGY) Claim 15; column 1, line 10	at least Claims 1, 15
X	US 4857110	(DESSAUER) Examples 4, 5	at least Claims 1, 15
X	US 4766015	(BERCEN) Claims 1-6; column 2, lines 22-30	at least Claims 1, 15
X	US 3928707	(NALCO CHEMICAL) Claims 1, 2; column 5, lines 63-68	at least Claims 1, 15

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